AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1-19 (Cancelled)

20. (Original) In a system with a logging tool having a dipole transmitter pair and a plurality of dipole receiver pairs spaced apart from the dipole transmitter pair and from each other, and where the orientation of each dipole transmitter is known, and where each of the plurality of dipole receiver pairs has one dipole receiver axially parallel with one of the dipole transmitters and another dipole receiver axially parallel with another of the dipole transmitters, a method of determining a velocity of a fast and slow shear wave polarizations in an anisotropic earth formation comprising:

transmitting acoustic signals with the dipole transmitters;

receiving the acoustic signals as composite signals with the plurality of dipole receiver pairs;

decomposing the composite signals into a plurality of decomposed signals;

estimating a source signal for each of the plurality of decomposed signals to create a plurality of estimated source signals; and

determining the acoustic velocity of the fast and slow polarized shear waves by comparison of the plurality of estimated source signals.

21. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 20 wherein transmitting an acoustic signal with the dipole transmitters further comprises, at each depth level of interest:

firing a first dipole transmitter of the dipole transmitter pair; and then

firing a second dipole transmitter of the dipole transmitter pair.

22. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 20 wherein decomposing the composite signals into a plurality of decomposed signals further comprises:

decomposing the composite signals a plurality of times using a plurality of strike angles in a range of possible strike angle extending from -90^0 to $+90^0$; and for each of the plurality of strike angles

estimating a source signal for each of the plurality of decomposed signals to create a plurality of estimated source signals.

23. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 22 wherein decomposing the composite received signals a plurality of times using a plurality of strike angles in a range of possible strike angles extending from -90^0 to $+90^0$ further comprises determining, for each strike angle in the range of possible strike angles, decomposing the composite received signals using substantially the following equation:

$$DS\ (t) = \cos^2(\theta)\, R_{XX}(t) + \sin(\theta)\cos(\theta)\, [R_{XY}(t)+R_{YX}(t)] + \sin^2(\theta)\, R_{YY}(t)$$

where DS(t) is the decomposed signal, θ is the strike angle, R_{XX} is a composite signal received by a receiver oriented in the X direction upon firing of a transmitter in the X direction, R_{YX} is the composite signal received by a receiver oriented in the Y direction upon firing of the transmitter in the X direction, R_{YY} is a composite signal receiver by a receiver oriented in the Y direction upon

firing of the transmitter in the X direction, and R_{XY} is a composite signal received by a receiver oriented in the X direction upon firing of the transmitter in the Y direction.

24. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 20 wherein decomposing the composite signals into a plurality of decomposed signals further comprises:

determining a strike angle of the earth formation; and

decomposing the plurality of composite signals using the strike angle determined.

25. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 24 wherein determining the strike angle of the earth formation further comprises solving the following equation for the strike angle θ:

$$\sin(2\theta)[R_{XX}(t) - R_{YY}(t)] - \cos(2\theta)\,[R_{XY}(t) + R_{YX}(t)] = 0$$

where R_{XX} is a composite signal received by a receiver oriented in the X direction upon firing of a transmitter in the X direction, R_{YX} is the composite signal received by a receiver oriented in the Y direction upon firing of the transmitter in the X direction, R_{YY} is a composite signal received by a receiver oriented in the Y direction upon firing of the transmitter in the X direction; and R_{XY} is a composite signal received by a receiver oriented in the X direction upon firing of the transmitter in the Y direction.

26. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 25 wherein decomposing the plurality of composite signals using the strike angle determined further comprises determining the fast polarization time series, FP(t) and the slow polarization time series SP(t) with substantially the following equations:

$$FP(t)=\cos^2(\theta)\, R_{XX}(t) + \sin(\theta)\cos(\theta)\, [R_{XY}(t)+R_{YX}(t)] + \sin^2(\theta)\, R_{YY}(t)$$

$$SP(t) = \sin^2(\theta)\, R_{XX}(t) - \cos(\theta)\sin(\theta)\, [R_{XY}(t) + R_{YX}(t)] + \cos^2(\theta)\, R_{YY}(t).$$

27. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 20 wherein decomposing the composite received signals and estimating a source signal for each of the plurality of decomposed signals to create a plurality of estimated source signals further comprises:

estimating a transfer function of the formation comprising at least a strike angle of the anisotropy and a slowness of acoustic waves within the formation;

decomposing the composite received signals based on the assumed strike angle; and

calculating the estimated source signals by applying the transfer function to each of the decomposed signals.

28. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 20 further comprising performing the transmitting and receiving steps using a wireline formation tester.

29. (Original) The method of determining a velocity of fast and slow shear wave polarizations as defined in claim 20 further comprising performing the transmitting and receiving steps with a tool on a drill string during a drilling process.

30-37 (Cancelled)

√

38. (Original) A method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation, the method comprising:

transmitting acoustic energy into the earth formation, and wherein the earth formation breaks the acoustic energy into the fast polarization shear wave and the slow polarization shear wave;

receiving composite waveforms comprising components of both the fast and slow polarization shear waves;

decomposing the composite waveforms into decomposed waveforms;

estimating source waveforms from the decomposed waveforms to create estimated source waveforms; and

comparing the estimated source waveforms to determine the orientation of fast and slow polarized shear waves.

39. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 38 wherein transmitting acoustic energy into the earth formation further comprises:

firing a first dipole transmitter in a first axial direction; then

firing a second dipole transmitter in an axial direction substantially azimuthaly perpendicular to the first axial direction.

40. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 39 wherein receiving composite waveforms comprising components of both the fast and slow polarization shear waves further comprises:

receiving a first set of composite waveforms with a first dipole receiver pair associated with the firing of the first dipole transmitter;

receiving a second set of composite waveforms with a second dipole receiver pair associated with the firing of the first dipole transmitter;

receiving a third set of composite waveforms with the first dipole receiver pair associated with the firing of the second dipole transmitter; and

receiving a fourth set of composite waveforms with the second dipole receiver pair associated with the firing of the second dipole transmitter.

41. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 40 wherein decomposing the composite waveforms into decomposed waveforms further comprises:

decomposing the first and third set of composite waveforms to create a first decomposed waveform; and

decomposing the second and fourth composite waveforms to create a second decomposed waveform.

42. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 38 wherein estimating source waveforms from the decomposed waveforms to create estimated source waveforms further comprises:

estimated acoustic velocity of the earth formation; and

applying the estimated acoustic velocity to the decomposed waveforms to create the estimated source waveforms.

43. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 38 wherein comparing the estimated source waveforms to determine the orientation of fast and slow polarized shear waves further comprises:

calculating an objective function based on the estimated source waveforms;

plotting the values of the objective function to create a plot; and

determining the orientation of fast and slow polarized shear waves by a search for inflection points in a plot containing the objective function.

44. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 43 further comprising:

plotting multiple objective function values calculated for multiple sets of estimated source waveforms; and

determining inflection points of the objective function values within the plot as indicative of orientation of fast and slow polarized shear waves within the earth formation.

45. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 44 wherein comparing the estimated source waveforms to determine the acoustic velocity further comprises finding locations where the inflection points are minimas.

46. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 45 further comprising estimating an

error in the determination of the orientation of fast and slow polarized shear waves based on a curvature of the value of the objective function at the minimas.

47. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 43 wherein calculating an objective function based on the estimated source waveforms further comprises:

averaging the estimated source waveforms to determine an average estimated source waveform; and

determining a variance value of the estimated source waveforms using the average estimated source waveform, the variance value being the objective function.

48. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 47 wherein averaging the estimated source waveforms to determine an average estimated source waveform further comprises determining the average estimated source waveform using substantially the following equation:

$$S_{EST_{AVG}}(t) = \frac{1}{N}\sum_{i=1}^{N} S_{EST_i}(t)$$

where $S_{EST_{AVG}}$ is the average estimated source waveform, N is the number of decomposed waveforms used to create the average estimated source signal, S_{EST_i} is the estimated source waveform for each decomposed waveform, and t is time.

49. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 47 wherein determining a variance

value of the estimated source waveforms using the average estimated source waveform further comprises:

$$\delta^2 = \sum_{i=1}^{N} (S_{EST_i}(t) - S_{EST_{AVG}}(t))^2$$

where δ^2 is the variance, $S_{EST_{AVG}}$ is the average estimated source waveform, N is the number of decomposed waveforms used to create the average estimated source signal, S_{EST_i} is the estimated source waveform for each decomposed waveform, and t is time.

50. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 47 further comprising:

plotting multiple variance values calculated for multiple sets of estimated source waveforms; and

determining inflection points of the variance values within the plot as indicative of velocity of fast and slow polarized shear waves within the earth formation.

51. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 50 wherein comparing the estimated source waveforms to determine the acoustic velocity further comprises finding locations where the inflection points are minimas.

52. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 38 wherein comparing the estimated source waveforms to determine the orientation further comprises:

calculating a differences between each estimated source waveforms to obtain an objective function using substantially the following equation

$$\zeta = \sum_{i=1}^{N-1} (S_{EST_{i+1}} - S_{EST_i})^2$$

where ζ is the objective function, and N is the number of decomposed waveforms, and S_{EST_i} is the estimated source waveform for each decomposed waveform.

53. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 52 wherein comparing the estimated source waveforms to determine the acoustic velocity further comprises:

plotting multiple values of the objective function calculated for multiple sets of estimated source waveforms; and

determining inflection points of the values of the objective function within the plot as indicative of orientation of fast and slow polarized shear waves within the earth formation.

54. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 53 wherein comparing the estimated source waveforms to determine the acoustic velocity of fast and slow polarized shear waves further comprises finding locations where the inflection points are minimas.

55. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 38 further comprising performing the transmitting and receiving steps using a wireline formation tester.

56. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 38 further comprising performing the transmitting and receiving steps with a tool on a drill string during a drilling process.

57. (Original) The method of determining an orientation of fast and slow polarized shear waves in an anisotropic earth formation as defined in claim 38 further comprising comparing the estimated source waveforms to determine the acoustic velocity of the fast and slow polarized shear waves.